



# Laser : Derma.

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- PUVA
- UVA-I
- UVB-NB
- Photodynamic Therapy PDT
- Extracorporeal photophoresis
- Caution
- Cryo

- 
- Laser Basics
  - principles - operation modes
  - Types
  - ch. ch.
  - Selective photothermolysis
  - laser parameters
  - laser - Tissue interaction according to Tissue optics  
Biological effects
  - laser Hazards
  - laser Ht of vascular lesion
    - port wine stain
    - IH
    - Telangiectasia
    - leg veins
  - laser Ht Hair Reduction
  - laser Ht pigmented lesion + tatto
  - laser Resurfacing + Rejuvenation

# Phototherapy - UV

## → Main Types of UV:

- UVA-1
- NB-UVB
- Excimer laser
- Photodynamic Therapy
- Extracorporeal photophoresis

## ① PUVA (photochemotherapy)

- Its :- Psoralen medication + Ultraviolet A

- Derived from 30 plants
- Derivatives :- 8-MOP  
5-MOP  
Trioxsalen
- Orally
  - ↑ photosensitivity 1 hr after
  - Peak 2 hr
  - Disappear 8 hrs
  - metabolized in Liver
- Locally
  - Penetrate Skin
  - Detect in Urine 4 hrs later

## - Mechanism of Action :-

1- Suppress DNA synthesis

2- Anti inflammatory + immunosuppressive effect :-

- suppression of production of Cytokines
  - induction of production of Anti-inflammatory + immunosuppressive molecules
- VEGF-  
IL-23  
IL-22  
IL-17  
IL-10  
α-MSH

- Affect Function + viability of Keratinocytes, lymphocytes, APCs.
- Induction of Apoptosis of lymphocytes, Keratinocytes

3- Stimulation of melanocytes :

- stimulate melanocyte function
- enhance migration of activated melanocytes



## Methods of treatment:

### Oral PUVA

- methoxalen
- 0.6 - 0.6 mg/kg
- Followed By → whole Body irradiation after 1-3 hrs By exposure to UVA lamps
- if UVA → not available  
↓  
Sunlight used instead  
30 min at 11-2 pm  
am

### Indications of PUVA

① FDA approved → Psoriasis  
→ vitiligo

② other

→ Neoplastic → MF • Sezary & • Histocytosis  
→ Immunological → Alopecia areata  
→ GVHD  
→ Morphea  
→ Pap. sq. + Dermatitis:

- Atopic Dermatitis
- Seb " "
- Hand " "
- Parapsoriasis
- lichen planus
- lymphomatoid Papulosis

→ Pruritic Dermatoses:

- Dermographism - chronic Urticaria - polycythemia vera

→ Photosensitivity:

- Polymorphous light Eruption - Solar Urticaria

→ Miscellaneous:

- scleromyxedema
- generalized annuloma annulare

(Bath-PUVA)

### Topical PUVA

- 8-MOP 0.1-0.01% → Cream  
→ Ointment  
→ Lotion
- Followed By UVA irradiation

### Disadvantages

- 1- non-uniform Distribution of Skin surface → unpredictable phototoxic Erythema Reaction
- 2- Application to surrounding uninvolved skin → unacceptable Hyperpigmentation
- 3- Extensive Application of 0.15% 8-MOP  
Causes plasma levels comparable to oral ingestion

## Protection During PUVA

### in PUVA unit

- Eye goggles
- Face sunscreen or pillow
- male genitalia (underpants)

### After exposure, oral psoralen

- Eye → UV opaque glasses until sunset
- Skin → clothing - sunscreen -

### Adverse effects:

#### ↳ Short Term Adverse effect

##### • others:

- ↳ CVS Stress
- ↳ Herpes simplex Recurrence
- ↳ photosensitive eruption

##### • Phototoxic

- ↳ Erythema ↳ Kobner
- ↳ pruritus ↳ Blister of Hand - feet
- ↳ Tanning ↳ Ankle edema
- ↳ Keratitis

##### • Methoxsalen alone

- ↳ GIT distress
- ↳ Broncho constriction
- ↳ Hepatic Toxicity
- ↳ Drug Fever

#### ↳ Long Term:

- Photoaging → NMSC → melanoma

## Contra indications of PUVA:

### Absolute

- pemphigous + pemphigoid
- lupus Erythematous
- Xeroderma pigmentosa
- Lactation

### Relative

- Photosensitizing medications
- prior exposure to ionizing Rad.
- Pregnancy
- Family History of melanoma
- V. Young Age

## Monitoring:

### • Baseline •

- skin for
  - ↳ Cancer
  - ↳ premalignant
  - ↳ Actinic damage

- Ocular
  - ↳ slit lamp exam
  - ↳ Fundoscopic Retina

- lab
  - ↳ LFT
  - ↳ RFT
  - ↳ lupus ANA Test

### • Follow up •

- Repeat Eye exam yearly
- Regular exam for skin cancer



## ② UVA - I

- Spectrum 320 - 400 nm - Divided  $\begin{cases} \text{UVA-1} \\ \text{UVA-2} \end{cases}$
- UVA1  $\rightarrow$  penetrate more deeply  
 $\rightarrow$  affect Epidermal + mid, deep dermal Component + Blood Vessels

### Mechanism of Action:

- in Atopic Dermatitis  $\rightarrow$  Induce T-lymphocyte apoptosis
- Cut. Mastocytosis  $\rightarrow$   $\downarrow$  number of Langerhans Cells + mast cells in Dermis
- Localized Scleroderma  $\rightarrow$   $\uparrow\uparrow$  Collagenase expression

### Indications:

- $\rightarrow$  Major:  $\begin{cases} \rightarrow \text{Atopic dermatitis} \\ \rightarrow \text{Scleroderma} \\ \rightarrow \text{Systemic lupus Erythematosus} \end{cases}$
- $\rightarrow$  Other:  $\begin{cases} \rightarrow \text{palmar - plantar Dermatitis} \\ \rightarrow \text{prurigo nodularis} \\ \rightarrow \text{Granuloma annulare} \\ \rightarrow \text{neerobiosis Lipodica} \end{cases}$

- S/E:  $\begin{cases} \rightarrow \text{Erythema} \\ \rightarrow \text{Long term: DNA Damage} \end{cases}$   $\leftarrow \begin{cases} \text{Keratinocytes} \\ \text{fibroblasts} \end{cases}$

## ③ UVB - NB

### Mechanism:

- 1 - Radiation  $\rightarrow$  Absorbed By nuclear DNA (endogenous chromophores)  
 $\rightarrow$  Formation of pyrimidine Dimers (DNA photoproducts)  
 $\rightarrow$  Reduction in DNA Synthesis  $\rightarrow$  Suppression of accelerated DNA Synthesis (in psoriatic cells)
- 2 - Induce Tumor suppressor gene p53  
 $\rightarrow$  Apoptosis of keratinocytes

### 3 - Immunosuppressive

- suppression of
  - contact allergy
  - Delayed type Hypersensitivity
  - UV-induce NMSc.
- langerhans cells → v. sensitive to UVB
- Keratinocytes → secrete IL-1 - IL-6 - PGE2

4 - Effect of Melanocytes: → stimulate melanocyte proliferation  
→ melanin production

### - Advantages over PUVA

- 1- Safe in Children + Pregnant
- 2- No need of post ttt Eye protection
- 3- No Drug to induce Nausea.
- 4- Exposure time is 1/4 of that PUVA

### - Indications:

- ↓ Major → Psoriasis  
→ Vitiligo.
- ↓ other: → Nesplastic → MF = PUVA  
→ pap. seq + Dermatitis

### - Contraindications: = PUVA

#### - Adverse effects:

- Short Term: → Skin
  - Erythema
  - Pruritus
  - Bullae
  - Phototoxicity
  - polymorphus light Eruption
- Autoimmune
  - L.E
  - pemphigus
  - pemphigoid
- Long Term: → Photoaging  
→ NMSc.

- Mucosal
  - Blepharitis
  - infection
  - Herpes labialis



# Photodynamic Therapy PDT

- Administration of → photosensitizing Agent Then Photoactivation By light
- PDT → Destroy cells & minimal Damage to Surrounding Healthy Structure

## Mechanism of Action:

- Cells in human Body → transform ALA, MAL to porphyrins
- porphyrins → Accumulate in → glands  
→ Epidermis
- Neoplastic Cells → Accumulate more porphyrin than normal cells
- following light activation → porphyrins → generate Reactive Oxygen species + Free Radicals
- Cause → Apoptosis of malignant cells  
→ used in Ht of skin infection
- Increase Collagen synthesis

## The Sensitizers:

- |   |   |
|---|---|
| ↓ <u>ALA</u><br>(Aminolevulinic acid)<br>topical or patch | ↓ <u>MAL</u><br>(methyl-Amino-levulinate) |
|---|---|

## Light Source:

- ① Laser: any laser e.g. W.L (400-800 nm) → used to activate ALA-MAL

- PDT laser is Better

→ monochromaticity → max effectiveness  
→ Can produce High irradiance to minimize The therapeutic exposure Time

## ② Non-Coherent light Source:

- 1- in Ht of large skin lesion
- 2- Superior to laser D.t large illumination field
- 3- Low Cost - smaller size - Available
- 4- Allow use different photosensitizer

16

6

## → Indications:

- |                      |                      |
|----------------------|----------------------|
| 1- PhotoRejuvenation | 5- Bowen's Disease   |
| 2- Acne vulgaris     | 6- Superficial B.C.C |
| 3- Verrucae          | 7- Nodular B.C.C.    |
| 4- Actinic Keratosis |                      |

## → S/E:

### → Photosensitivity

→ Pain : unpleasant sensation sc. - mints  
warmth - Burning - Stinging - Stabbing

### → Inflammation:

at The end of light exposure → 24-48hr later

### → Other: → Scarring

→ Post inf. Hyper-Hypopigmentation

### → Photosensitizer Allergy

## → Contraindication:

- Porphyria
- Hypersensitivity + Allergy to Porphyrin
- Children < 8yr

## ExtraCorporal photopheresis

### \* Procedure:

- ① Ingestion of 0.7 mg/kg - 8-Mop.
- ② 1-2 hr later → venous access peripherally
- ③ aliquots of Blood Removed → separated into Cellular fraction (Repeated 6 cycles)
- ④ 40 mL of leukocyte fraction or Buffy coat → Collected held for 14
- ⑤ serum + RBCs → Reinfused into ptn [7]
- ⑥ photoactivation of Buffy coat fraction → pass Through Chamber → exposed to UVA
- ⑦ Photomodulated cells → Reinfused into ptn [7]



## ● Adverse effects:

### 8-MOP:

- nausea
- photosensitivity

### CVS

- Hypotension
- CHF
- Flushing

### Venipuncture

loss of venous access  
with Repeated venipuncture

## ● Mechanism of Action:

① Psoralen + UVA → generate single Oxygen

- Ptn immune system then

↓  
Able to mount response  
against these antigenically  
altered cells

↓  
generate lipid peroxides

↓  
generate new antigenic  
Determinants on cell membrane

② Induction of Apoptosis of Activated T-cells

③ Induction of Immunoregulatory Cytokine shifts

## ● Indications:

① FDA approve

→ T-cell lymphoma

② Autoimmune CT

→ Scleroderma

③ Autoimmune Bullous

→ p.v

→ p.f

→ EBA

④ GVHD → Acute  
                                    ↳ Chronic

⑤ other → Nephrogenic fibrosis  
                                    ↳ Oral L.P

## ● Contraindications

### Absolute

- pregnancy + lactation
- Sever CVS Disease

### Relative

- poor venous Access
- Rapid Progressing Disease
- Hct < 25%
- Diastolic BP < 70 mmHg
- Congestive HF

## Electro Cautey

D.F: Thermal Cautery, surgical procedure  $\rightarrow$  uses High Frequency Energy to Cauterize, Coagulate or Cut Soft Tissue

mechanism of Action:

- Electrosurgical equipment → Converts Domestic alternating Current into High Frequency alternating Current.
- When this Currents → meets the high Resistance of the Skin → it produce heat
- if heat → Delivered as intermittent pulses → Desiccation + Fulguration
- continuous pulses → Cell membrane Rupture
- Deliver heat at a single temperature or Range of Temperatures Between  $100^{\circ}\text{C}$  —  $1200^{\circ}\text{C}$
- Should consider the
  - properties of tissue.
  - area + Depth of destructive area
  - possible complication
- It's a procedure That utilize the passage of High-Frequency alternating electrical Current through living Tissue. to Achieve Varying Degree of Tissue Destruction
- Produce Electromagnetic Interference.

● Indication:

- ① Dissection + Fulguration
- warts
  - Condyloma
  - Skin tag
  - Actinic Keratosis
  - Seborrhic Keratosis
  - Molluscum
- ② Coagulation:
- Pyogenic Granuloma
  - Cherry Nevi - Spider Nevi
  - Telangiectasia
- ③ Section: → Nevi → BCC.
- Dissection + Fulguration



## ● Effect on tissue:

1- Electrodissection: • active electrode Touch the skin → tissue Destruction

- Current is High frequency
- damped
- Low amperage
- High voltage

2- Fulguration: • electrode is held away from skin → producing a spark at skin surface → Shallow Destruction

- Current is v. High voltage
- Very High frequency
- Very Low amperage
- High Damped

3- Coagulation: • Ideal for clotting small vessels < 2mm

- Voltage - frequency - damping → Smaller
- Amperage → Higher

4- Electrosection: • to Cut Tissue

- High voltage - frequency
- Low Amperage
- un damped

● Contraindications:

- Burns
- Electric Shocks
- Transmission of infection
- Eye injury

Complications:

(No absolute contraindications)

# Cryo

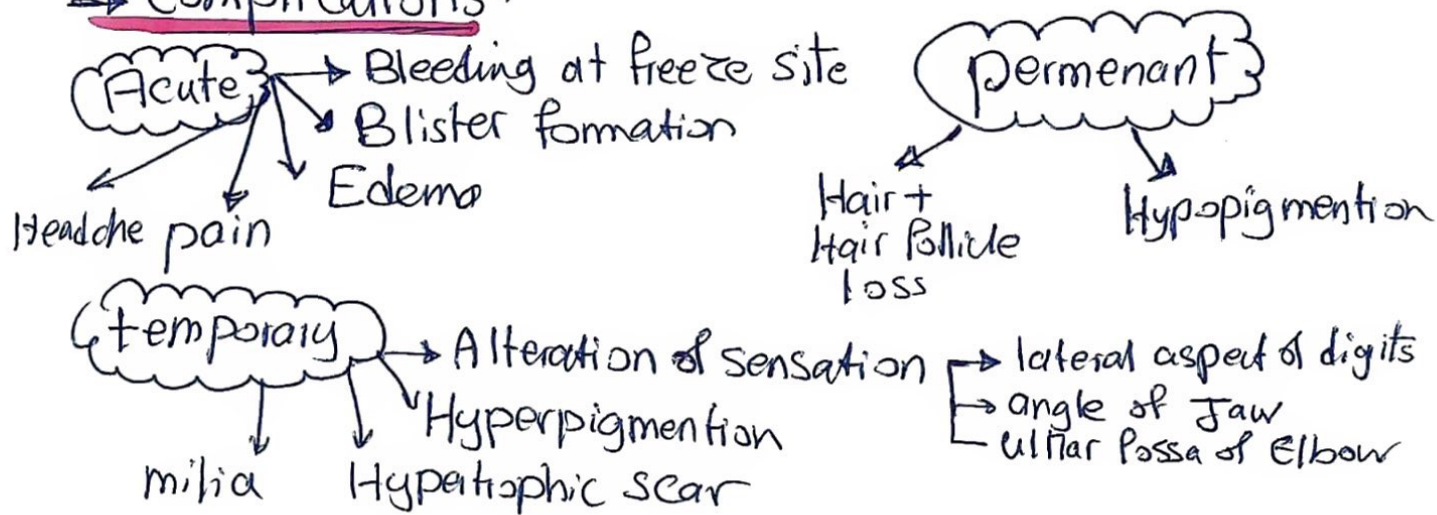
→ D.F :- Destruction of skin By Freezing

→ Types: ① CO<sub>2</sub> snow  
② liquid nitrogen

→ Indications:

- AK
- Cut Moins
- Hyperkeratotic Scar
- Keloid
- Solar lentigo
- Dermatofibroma
- BCC - SCC
- warts
- pyogenic granuloma
- Skin Tag

→ Complications:



→ Contraindications:

Absolute

- 1- lesions for which a biopsy for pathology Required
- 2- lesion at area e Compromised Circulation → Cartilage
- 3- Melanoma
- 4- Adverse Reaction to Cryo

Relative

- 1- cold urticaria
- 2- Collagen - Autoimmune disease
- 3- Heavily pigmented skin
- 4- area as → pretibial, eyelid margin
  - Nasolabial folds, ala nasi
  - Hair Bearing area
- 5- multiple myeloma
- 6- Raynaud's

→ Mechanism:

→ temperature -25, -50°C within 30 sec

→ Benign lesion → -20 - -30°C

→ malignant lesion → -40 - -50°C

• Degree of Damage Depend on  
→ Rate of cooling  
→ minimum temp. achieved.

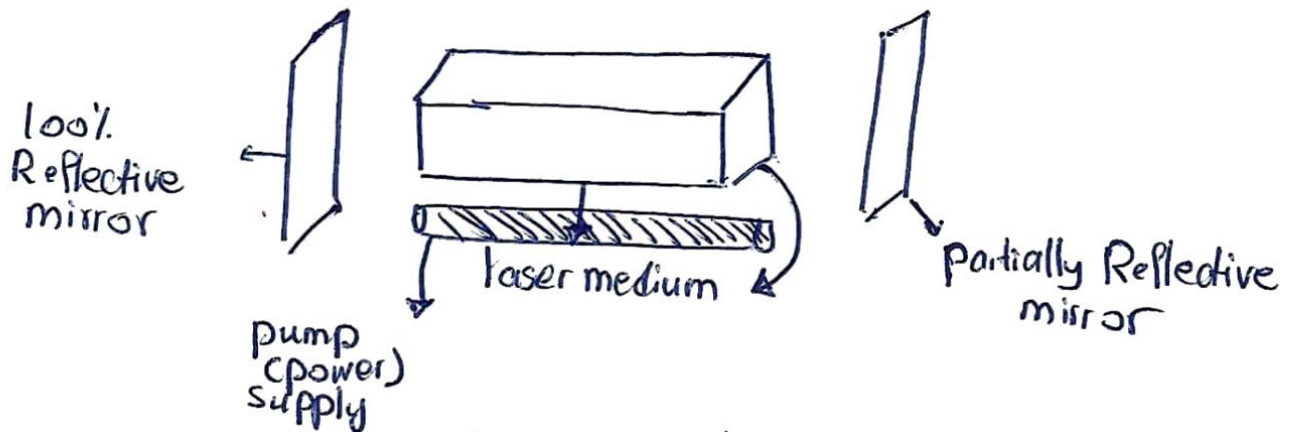
II

... formation



## ★ laser principles

all lasers composed of 4 components



### 1 laser medium: (solid - liquid - gas)

usually Type of laser named for medium contained within the optical cavity

### 2 Optical cavity: (Resonator)

- surround The laser medium, contain the Amplification process
  - Highly Reflective chamber
  - with 2 parallel mirrors on each side
- one fully Reflective  
other partially Reflective

### 3 Power Supply (pumping source)

- electrical - Thermal - optical - chemical
- To supply Energy to laser medium → excites the atoms and create Population inversion

### 4 Delivery System

- Fiber optic or articulating arm & mirrored joint
- To deliver the light to The Target

## ★ laser Operation modes

### Continuous mode

- Low power laser
- produce constant Beam of light

### Pulsed mode

- produce pulses from microseconds to millisecond widths
- Superpulsed (v. short)

### Q-Switched

- v. short pulses (nanoseconds, picoseconds)
- extremely High peak



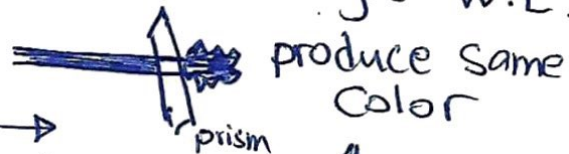
# \* Types of laser

Name	Type	wavelength
- Excimer	Gas	308 nm
- Argon	Gas	488 - 514 nm
- KTP	Solid	532
pul sed Dye	Liquid (rhodamine dye)	585 - 595
Helium-Neon	Gas	632 nm
Ruby	Solid	694
Alexandrite	=	755
Diode	=	800 - 810
Nd:YAG	=	1064 & 1320
Diode	=	1450
Erbium: Glass	=	1540 & 1550
Erbium: YAG	=	2940
Carbon Dioxide	Gas	10600

## \* Laser light ch. ch Differ from other light sources

### 1) Monochromatic :-

- in contrast to sunlight which have wide spectrum wavelengths
- laser light emits light of only clear defined single w.L.
- laser light show through prism
- white light show through prism → Produce the entire spectrum of colors



### 2) Coherence :-

- D.F: it means that the electromagnetic waves of light are in phase & respect of space and Time
- 2 Types:



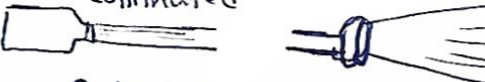
→ Spatial: crests + troughs of all waves coincide along lines perpendicular to rays

→ Temporal: frequency-wavelength-speed of Travel are all constant

[2]

[2]



3- Collimated:  Divergence 0.

- The transmission of light occur in parallel fashion without Divergence even at Long Distances

4- Brightness or intensity:

- its arise from Collimation of laser light
- its moves through space maintaining its Concentration and Brightness

## ★ Selective photothermolysis

→ D.F.: The ability to Target specific Chromophore in skin without Damaging Surrounding Structures.

- Through selection of proper  $\leftarrow$  wavelength  
pulse Duration  
Energy used.

→ Chromophore <sup>= color</sup> carrier

- its The chemical entity That absorbs specific w.L of electromagnetic spectrum

→ Endogenous: melanin - Hb - water - fat  
→ Exogenous: Tatto ink.

## ★ Laser Parameters

1- Proper wave length: w.L is the physical distance Between the crests of successive waves in Beam.

- Shorter w.L absorbed more strongly By melanin

- longer w.L penetrate Deeper and Safer to use in people with Darker skin

2- proper Energy: its The number of photons delivered in Single pulse.

3-  $\left\{ \begin{array}{l} \rightarrow \text{Energy contained within light} = \text{Joules (J)} \\ \rightarrow \text{its Fluence (energy density (amount of laser energy delivered))} \end{array} \right.$



3- pulse Duration: its Time During laser actually emits Energy.

- Should Be = equal or < less Than

[Thermal Relaxation Time TRT of Target]

its Time Required for heated Target to lose half of its heat Through thermal diffusion to Surrounding Tissue

Chromophore Target	TRT
Melanosome	20-40 ns
Tatto pigment	20 ns - 3 ms
Epidermis	1 ms
Telangiectasia	1 ms
Blood vessel	5-30 ms
Melanin in hair	20-100 ms

4- Frequency: its number of pulses per 1/second.  
 • measured By Hertz  
 • 1 Hz = 1 pulse per second.

5- Spot size: = laser Beam Cross Section

- Fluence  $\propto$  inversely proportional to Square of Radius of spot size
- Small spot size  $\rightarrow$  allow more scattering
- The larger The SZ  $\rightarrow$  Deeper is penetration

6- Cooling: 3 forms

- Cold air Convection
- Contact cooling
- Cryogen spray cooling

## Laser-Tissue Interaction

- Light is the energy  $\rightarrow$  Carried in form of traveling wave.
- Composed of - electric - magnetic fields [electromagnetic Spectrum EMS]

• Light Divided into:

1- U.Violet (200-400 nm)

2- Visible (400-700 nm)

3- Infrared (IR)  $\rightarrow$  near IR (NIR)  $\rightarrow$  750 nm - 2  $\mu$ m  
 $\rightarrow$  mid IR (MIR)  $\rightarrow$  2 - 5  $\mu$ m

[4]



# ① Laser-Tissue Interaction

According to

Tissue Optics :- (Laser Reach skin  $\rightarrow$  interact w/ Tissue By 4 Different ways)

## 1. $\rightarrow$ \* - Reflection:

- 4-7% of light Reflected at Right angle of skin surface



Repelling of light off the surface of skin without enter into Tissue

- to Reduce laser Reflection

$\rightarrow$  keep the Beam perpendicular to skin  
 $\rightarrow$  keep firm Contact Between laser head and skin

## 2. $\rightarrow$ \* - Scattering:

- its the Redirection of photons away from its Direction of light Travel

- occur inside skin

Reflection  $\rightarrow$  انعكاس

- its D.t Collagen in Dermis

- effect of scattering:
  - $\rightarrow$   $\downarrow$  light Energy available for absorption
  - $\rightarrow$  limits The depth of penetration  $\rightarrow$
  - $\downarrow$  clinical effect

- Factors affecting Scattering:

1. W.L dependant  $\rightarrow$  Scattering is greater +  $\uparrow$  Random in Shorter W.L

2. Spot size  $\rightarrow$  less Scattering w/ Large spot

3. Tissue Composition  $\rightarrow$  Thicker epidermis  $\rightarrow$  more Scattering

## 3. $\rightarrow$ \* - Transmission:

- light That Not Reflected  $\rightarrow$  absorbed - to Deeper Tissue

- Depend on: W.L  $\rightarrow$  Shorter W.L (300-400nm)  $\rightarrow$  Penetrating  $< 0.1$  mm  
W.L (600-1200)  $\rightarrow$  penetrate deeper

## 4. $\rightarrow$ \* - Absorption:

- photon Absorbed By Target molecule  $\rightarrow$  all Energy is transferred

- Degree of interaction  $\rightarrow$  proportion to level of Absorption of W.L By Tissue  $\rightarrow$  UV spectral



## ② Laser-Tissue interaction According to

Biological effects : Depend on  $\begin{cases} \rightarrow \text{actual Temperature} \\ \rightarrow \text{Exposure time} \\ \rightarrow \text{laser pulse mode} \end{cases}$

↳ 1\* Photochemical Reactions :-

include :-  $\begin{cases} \rightarrow \text{PhotoBio stimulation (Low level light therapy)} \\ \rightarrow \text{photoDynamic Therapy} \end{cases}$

↳ 2\* Photothermal (photothermolysis) :-

- light energy  $\rightarrow$  Absorbed By tissue  $\rightarrow$  transformed to Heat ~~Energy~~
- According to Degree of heating :-

temperature	Biological effect
42-45°C	-Hyperthermia - Shrinkage of collagen
50°C	Reduction of enzymatic activity
60°C	Denaturation of protein - Coagulation of collagen
100°C	Vaporization
>100°C	Carbonization
300-1000°C	photoablation + Disruption

- used in:- Laser Hair Reduction
- laser Ht of Vascular lesion
- laser Resurfacing

↳ 3- Photomechanical Reaction:-

D.F. mechanical Tissue changes D.t High Energy or Ultra-short pulsed laser

- laser Beam Energy  $\rightarrow$  transformed into  $\rightarrow$  Vibration or Kinetic Energy

Immediate Disruption of viable Tissue  $\leftarrow$  or generation of Shock waves  $\leftarrow$  Result in  $\leftarrow$

- Q-switched laser  $\begin{cases} \rightarrow \text{pigmented lesion} \\ \rightarrow \text{Tattoo} \end{cases}$

[b]



# Laser Hazards :



→ Acute exposure → Corneal - Retinal Burn  
→ Chronic exposure → Cataract - Retinal injury

Avoid

→ protective eyewear for all persons in laser room  
→ " " " chosen Based on W.L  
→ " " " Designated e' W.L + optical density OD

- OD parameter → measure How much light filtered out By lens  
→ The higher OD → greater protection By eyewear

- Types of waves:

• microwave - X-ray - Gamma Rays → Pass e' little absorption

• UV (315 nm - 280 nm - UVB  
Far (280 - 100 nm UV-C) ] → Scleral or Corneal surface  
IR (2000 nm - 1 mm)

• Near UV (315 - 400) → lens

• Visible - near IR (400 - 700, 700 - 1200) → Anterior structure of eye + Retina



- Range from Erythema → Burn → Scar

- its D.t → Acute exposure to High level  
→ Improper Device  
→ Improper Technique



Inhalation:

→ any laser creat plume of smoke <sup>UV</sup>  
Harm the Doctor, ptn, room personnel

Avoid → Smoke evacuator  
→ wearing Masks

products of HPV - Blood, tissue  
Bacteria

Laser Splatter:

- Q-Switched Laser → Disrupt surface of skin → Blood + skin  
Fragments → Flying away from operative site to

very High speed

- Avoid: Face Shields

5- Chemicals: some laser Require toxic substances to operate (chemical dye)



# ★ Laser Ht of Vascular lesion ★

- 1- Target chromophore → Hgb • Oxy Hgb • met Hgb • clot
- 2- majority of Hgb → Oxy Hgb
- 3- Met Hgb → generated from injury of Blood During laser Ht  
 clot → have greater absorption > oxy-Hgb (4 times)
- 4- after absorption of laser By Oxy-Hgb → light Energy <sup>converted</sup> → Thermal Energy  
 ↓  
 photo coagulation  
 mechanical injury  
 photochemical  
 Selective microvascular Damage.  
 ← Diffuse within Blood vessel

## 5- laser tissue interaction & Biological effect

- photo thermal effect: laser light → transformed to Heat  
 Causing thermal Damage & Coagulation in targeted vessels
- photo mechanical: PDL → sudden heating → vessel wall Rupture + Purpura.
- photochemical: Pulsed Dye laser → photooxidative Reaction + Cytotoxic effect

## 6- Factors affecting laser Absorption:

- (A) wave length: longer wave length → Deeper penetration
- 1- Oxy-Hgb → 3 absorption peaks → 418 → (Highest absorption)  
 542 nm  
 577 nm
  - 2- most common Vascular lasers:-  
 KTP (532) • PDL (585 - 595 nm) • Near IR-Alexandrite (755 nm)  
 Diode (800-910, 940 nm)  
 Nd:YAG (1064), IPL source & appropriate vascular filter

## (B) Pulse Duration:

- 1- Depend on Bl. Vessel Size - pulse Duration  
 • exposure time should Be long enough to Conduct heat from RBC → to entire Bl. wall



2 - Permanent vessel closure → Don't contain any strongly absorbing chromophores → Can be damaged by heat diffusion from blood

3. Optimal pulse Duration: 30-100  $\mu$ m in Diameter = 1-10ms

- 3ms → Cause purpura mode (Rupture blood vessels)
- 6ms → Subpurpuric mode (slowly heating the vessels → Coagulation)

C-Fluence: - Based on:

- Color - Purple - Blue vessels → Absorb light energy more than pink - Red vessels (Require less fluence)
- Size - Smaller vessels - Smaller spot size (Require high fluence)
- Pressure - Vessels under great pressure (nose-legs) → (High fluence)

D-Spot Size:

Large ss → have Deeper penetration →  $\downarrow$  total # time  
Small ss → need to produce Higher Energy

E-Cooling: - epidermal cooling → allow Ht to occur at Higher Energy fluence without increase incidence of Scarring

## 1 - Port wine stain

1. goal: -  $\downarrow$  the Red violaceous color, improve appearance
2. # pws Early: → prevent Hypertrophy
3. Site: Face-neck pws → Respond Better than leg-Hand
4. Age: # of young children → Respond Better than Adult (Thinning skin)
5. PDL i.e. Epidermal cooling → # of choice
6. Darker skin type: Cooling + longer pulse Duration
7. Alexandrite - Nd:YAG laser



## 2- Infantile hemangioma

1. Early Ht → Slow + stop proliferation  
→ ↓↓ Scarring and other problems

2. Types of laser:

→ PDL

→ treat early macular stain of IH  
→ superficial Infantile H.  
→ promote healing of ulcerated IH.  
→ Residual telangiectasia present after involution of infantile H.

→ KTP-IPL → superficial Hemangioma

→ Nd:YAG → Thick-Deep Hemangioma

## 3- Telangiectasia

→ PDL (585-595 nm) → Facial Telangiectasia.

→ e stacking pulses of Lower fluence + longer Pulse Duration  
Vessel clearance + ↓↓ facial edema + Erythema

→ KTP (532 nm) → Superficial Blood vessels

→ Long pulsed Alexandrite (765 nm)  
Diode (800-810-940 nm)  
Nd:YAG } for Deeper and Larger vessels

## 4- Leg veins:

→ PDL (585-595 nm) → Superficial tiny Telangiectasia  
Size (0.1-0.2 mm)

- Pulse Duration (1.5-40 ms)

- Risk of Dyspigmentation in Darker skin

→ long pulsed Alexandrite (765 nm) →

medium size vessels (0.4-1 mm)

→ Diode (800-810-940 nm) → Penetrate Deeper + large veins

→ long pulsed Nd:YAG → milestone Ht of Leg veins



## 7 - Side effect + Complications of laser # vascular lesion

<u>Pigmentary changes</u>	<u>Swelling</u>	<u>Scarring</u>	<u>Ulceration</u>
<ul style="list-style-type: none"> <li>Transient</li> <li>↑ e Darker skin</li> </ul>	<ul style="list-style-type: none"> <li>- when fl e near IR laser</li> <li>- e non-purpuric multiple PDL Technique</li> </ul>	<ul style="list-style-type: none"> <li>↑ e PDL + near IR</li> <li>- minimized By test pulse</li> </ul>	<ul style="list-style-type: none"> <li>Risk is Higher e Longer W.L lasers</li> </ul>

## ★ Laser # in Hair Reduction ★

- Chromophore in laser Hair: Melanin in (Hair shaft matrix cells)  
: actual Target Follicular stem cells
  - melanin: absorb wide spectrum of W.L
  - Eumelanin + Dark Hair Follicle : has Broad absorption spectrum UV light to near IR
  - Pheomelanin: Poorly absorbs the W.L → ineffective for permanent Reduction of Red or Blond Hair
- Complete Destruction of Hair Follicle:  
when Both germinative cells & Stem cells in Bulge → Destroyed in Bulb
- Anagen Stage → Sensitive to Hair Reduction By laser  
Catagen Stage → Resistant
- Laser - Tissue interaction (Biological effect) 3 mechanism
  - Photothermal: - Fundamental concept  
- Based on principle of SPT
  - Photomechanical: - e Q-Switched laser → at early stage of laser Hair removal → Temporary Hair Loss  
- Today's its minor relevance
  - Photochemical:  
- when Photosensitizer used e light source → Oxidative



## 5 - Factor affecting Laser Hair Reduction efficiency:

- ① Wave length: - shorter w.L absorbed more strongly By melanin  
- longer w.L penetrate Deeper + safer in Darker skin

- most common lasers.

<u>Ruby (694 nm)</u>	<u>Alexandrite 755 nm</u>
<ul style="list-style-type: none"><li>- the Original system</li><li>- High in melanin absorption</li><li>- limited to type I-II-III</li><li>- lack of penetration (2mm) ↓ poor results of this laser</li></ul>	<ul style="list-style-type: none"><li>- High melanin absorption</li><li>- limited to Type I-II-III</li><li>- Penetrate Deeply to affect the growth center of Hair</li><li>- Best fit for light - fine Hair</li></ul>
<u>Diode 800-810 nm</u>	<u>Nd:YAG (1064 nm)</u>
<ul style="list-style-type: none"><li>- slight less in melanin absorption</li><li>- suitable for all skin types</li><li>- penetrate more deeper than Alexandrite</li></ul>	<ul style="list-style-type: none"><li>- Low melanin absorption</li><li>- Safer in Darker skin types</li><li>- Penetrate Deeper than diode laser</li></ul>
<u>IPL @ appropriate filter 600-1200</u>	
<ul style="list-style-type: none"><li>- wide w.L</li><li>- using cut. off filter</li><li>- for All skin types</li></ul>	

Range (150-300  $\mu$ m)



→ follicle size.

→ Pulse Duration (TRT)  
(10-100 msec)

## ② Pulse Duration:

- Depend on → actual Target: not pigmented or pigmented structure

- Pulses longer than TRT of hair shaft

- Laser Hair Removal (LHR) is Better explained By extended theory of SPT

## ③ Fluence: → Higher Fluences → greater long term Hair Reduction

→ Initial signs of Adverse Reaction: → Erythema



④ > Spot Size: large spot size → Deeper penetration  
↳ Reduce total # Time

⑤ > Cooling: melanin in Epidermis → competing site of absorption

## 6 - laser # indications:

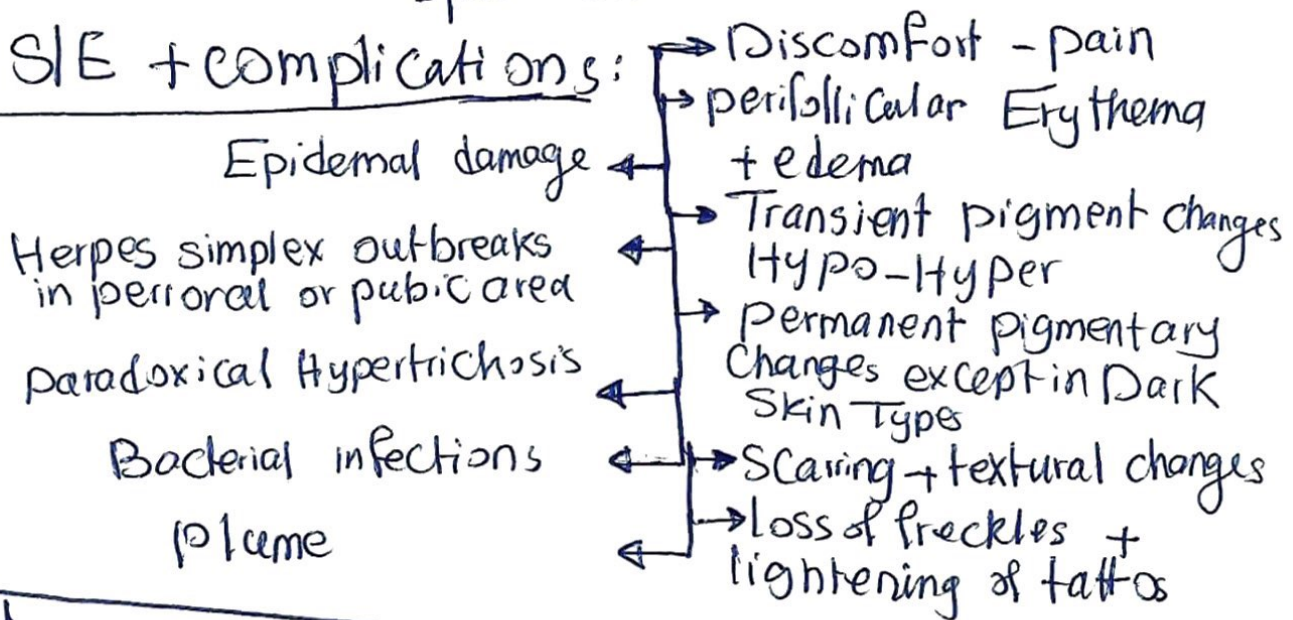
### ↓ Unwanted hair

- Hirsutism
- Hypertrichosis
- Cosmetic concerns
- Hair Bearing flaps

### ↓ Disease related to Hair follicle

- Pseudofolliculitis Barbae
- Acne Keloidalis nuchae
- Dissecting Cellulitis
- Hidradenitis Suppurativa
- Pilonidal sinus

## 7 - S/E + complications:



## ★ laser # of pigmented skin lesion + tattoo

1. Q-Switched laser → selective Destruction of pigmented lesions (selective photothermolysis)

2. in tattoo: Chromophore is: exogenous placed ink  
in Benign pigmented lesion Chromophore: melanin

3. Several laser today used: lasers that are:

[13]

→ Highly Pigment selective

→ Pigment non-selective

→ Somewhat Pigment selective



## 4 - Laser-tissue interaction (Biologic effect):

### Photomechanical

- Destruction of pigment
- through photo-acoustic injury
- target is small  $\rightarrow$  use pulse
- Duration extremely short
- nanoseconds - picoseconds

### Photothermal

- photothermal Destruction of pigment
- Fractional photothermolysis

## 5 - Factors affecting efficiency:

- ① wave length:  $\rightarrow$  shorter w.L  $\rightarrow$  absorbed more strongly by melanin
- Red - near IR  $\rightarrow$  longer w.L  $\rightarrow$  penetrate deeper + safer
- $\rightarrow$  most commonly used laser + light sources

Qs KTP  
532 nm

High melanin absorption  
limited in penetration  
Depth

Qs Ruby  
694 nm

Higher in melanin  
 $\rightarrow$  limited to Type I, II, III

Qs Alexandrite  
755 nm

High melanin  
Safe in ~~Dark~~ skin I, II, III

Qs Nd:YAG  
1064 nm

Safe in Darker skin  
 $\rightarrow$  penetrate deeper

- $\rightarrow$  Carbon Dioxide  
Erbium-YAG  
Erbium-glass  
Yttrium Scandium
- laser are pigment non-selective laser  
Remove epidermal pigment

- $\rightarrow$  Long pulsed - KTP - Alexandrite  
Nd:YAG - pulsed Dye lasers  
IPL
- in superficial pigmented lesions

## ② pulse Duration:

Qs  $\rightarrow$  pre-set - nonvariable pulse Duration  $\rightarrow$   
Can't Be changed By operator

$\rightarrow$  Ultra short pulse Duration  $\rightarrow$  effective

$\rightarrow$  Chromophore target

$\rightarrow$  melanosome  $\rightarrow$  TRT  
20 - 40 ns



(3) Fluence: Begin @ Lowest energy fluence.  
That produce Visible Response

(4) Spot Size:

Large spot size → Deeper penetration

## 6 - ptn Related Factors:

↓  
Skin type:

- lighter skin I-II-III have several laser options
- Darker skin ptn → need laser w/ longer w.L

↓  
Type of pigmented lesion:

- Shallow w.L → used in Epidermal lesions
- Dermal lesion → news of ota - its need Longer w.L

↓  
Type of tattoo

- the Older the tatts The Better Response (macrophages already present in skin to phagocytose the pigment)
- Amature tatts → more Easy to Removed than professional (multicabi) tatts.

## 7 - laser tt indications:

↳ Epidermal

- Ephelides
- freckles
- lentigines
- Cafe-au-lait macules

1. Benign

↳ Dermal:

- News of ota + ito
- Acquired Bilateral News-ota-like macules

↳ Dermo-Epidermal

- melasma
- Becker's nevi
- Drug induced pigment
- melanolytic nevi

2. Tattoo

Cosmetic  
medical

→ Amateur  
→ Professional  
→ Traumatic

## 8 - S/E + complications:

1- Alteration of pigmentation: post inflam. Hyperpigment  
Hypopigment

2- Paradoxical Darkening of tatts pig

3- Inadequate Response:

4- Localized Allergic Reactions (immediate Hypersensitivity Reaction)

5- Tattoo granulomas: allergic granuloma to one of inks

6- Recurrent lesion



# Laser Resurfacing + Rejuvenation

1- target chromophore → Water

Contain structure at differing depths  
Throughout skin →  
→ Epidermal Keratinocytes  
→ collagen  
→ Blood vessels

## 2- Ablative Resurfacing:

- non-fractional method
- Prolonged post-op. recovery
- Improve skin quality Through physical Removal or Vaporize a portion

## 3- Non-Ablative:

- good alternative for pt who desire modest improvement of Photodamaged skin

- without significant post-Ht Recovery
- Improve skin quality without Physical Removal or Vaporization

## 4- Fractional:

- Damage Certain Zones within selected target area leaving other zones within intact
- Stimulating → turnover + Remodeling of Epidermis + Dermis  
↓  
allow skin heal faster

- 2 Types of Fp:
  - non ablative
  - Ablative

- Advancing of non-ablative vs Ablative

- 1- St. Corneum → Remain intact
- 2- Re-epithelization + wound healing Rapid

achieved within 24hr

- 3- No Significant Downtime
- 4- safe in Darker skin type

## 5- Laser - Tissue Interaction (Biological effect)

- Change in tissue temp + Rate of healing →

[16]

[17]



- temperature  $> 60^{\circ}\text{C}$   $\rightarrow$  Denaturation of proteins  
 $> 70^{\circ}\text{C}$   $\rightarrow$  Denaturation of DNA

$60 - 140^{\circ}\text{C}$   $\rightarrow$  Vaporization of tissue water & Cell shrinkage  
 $\rightarrow$  membrane Rupture  
 $\rightarrow$  Protein Denaturation  
 $\rightarrow$  Collagen hyalinization

$300 - 1000^{\circ}\text{C}$   $\rightarrow$  tissue ablation

## 6 - Factor affecting efficiency:

1 \* W.L  $\rightarrow$  water absorption Co-efficient  $\rightarrow$  major factor  
 $\rightarrow$  Divided into 2 main Categories  
 $\rightarrow$  Ablative: Highly absorbed By water  
 $\rightarrow$  non-Ablative: less W.L absorbed By water

- Ablative  
Skin resurfacing

- CO<sub>2</sub>  
- Er:YAG

- Ablative  
Fractional laser

- CO<sub>2</sub>  
- Er:YAG  
- Er:Yttrium Gallium

- non-Ablative  
Skin resurfacing

- visible light:

KTP - pulsed Dye laser

- Near IR:

Nd:YAG (1064 - 1320)

- non-Ablative Fractional laser

~~CO<sub>2</sub>~~: YAG - Nd

- Diode

- Erbium. Glass

## 2 \* Pulse Duration:

- Short pulse width

$\downarrow$   
allow ablation Before  
significant heat diffusion

- Long pulse width  $\rightarrow$  allow

more heat transfer Before ablation  $\rightarrow$  greater Thermal effect

on surrounding Tissue

## 3 \* Density of Ht:

- Dot spacing  $\Rightarrow$  Spacing Between Consecutive Dots

= Density of Ht  $\rightarrow$  Depend on 1- Spot size

2- Distance Between

micro-Beams  $\rightarrow$  number

4\* Spot Size:

5- Skin Cooling: alleviate Pain During Ht

## 7 - laser Ht indications

1- moderate severe photo Damage

2- skin laxity

3- Acne Scarring

4- Traumatic - Post Burn scar

5- AK

6- Stretch marks

7- melasma

## 8 - SJE - complications:

### Ablative

1- open exudative wound

2- post Ht Edema + Erythema  
During 1st 48hr

3- Pinpoint Bleeding &  
Deep dermal penetration

4- line of demarkation Between  
Treated - non treated area

5- Post inflammatory  
Hyperpigmentation

### Non-Ablative

(mild - Transient)

1- Erythema + Edema  
last 48hr

2- Darkening of skin  
(Bronzing)

3- Microscopic epidermal  
necrotic debris (MEND)